EU's Emissions Trading System in the Presence of National Emission Targets

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Abstract

In 2005 EU will launch its emissions trading system (ETS) under which energy intensive firms within EU may trade carbon emission allowances. This system is by many seen as instrumental for EU's ability to fulfill its Kyoto commitment. At the same time, in what seems to be an ambition to go one step ahead, Germany, Sweden and the UK have adopted national greenhouse-gas emission targets equal to or below the so-called Assigned Amounts that EU's burden-sharing agreement for 2008-12 allots to these countries. It is shown here that implementation of these policies means that EU's greenhouse-gas emissions during 2008-12 would be an increasing function of the aggregate net sale of emission allowances by ETS firms in countries with national emission targets. One implication of this circumstance is that the climate policies announced by Germany, Sweden and the UK are incompatible with the burden-sharing agreement and the Kyoto Protocol.

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1. Introduction

In what seems to be an attempt to go one step ahead in adjusting to future, more demanding emission reduction requirements Germany, Sweden and the UK have adopted national emission targets equal to or below the so-called Assigned Amounts (AAs) that EU's burden-sharing agreement (EU, 1998) allots to these countries for the period 2008-12. Germany (2003) states a target equal to its allotment while the targets of Sweden and the UK are substantially below their allotments.[1] Sweden (2002) articulates an ambition to retire AA units in the amount of the difference between its AA and its national emissions target. The UK (2000) announces that it may retire, save or sell AA units corresponding to the difference between its AA and its national target. Obviously, countries with national emission targets cannot use the flexible mechanisms of the Kyoto Protocol (UN, 1997) to adjust their emission levels.[2] However, also German, Swedish and British energy intensive firms will be part of EU's emissions trading system (ETS) that begins in 2005 (EU, 2003a).

The ETS will begin with a compliance period that runs from 2005 to 2007. Subsequent periods will coincide with the compliance periods of the Kyoto Protocol (KP). So, the second period of the ETS will span over the years 2008-12. Prior to a compliance period, each member state has to allot emission allowances to its ETS firms (trading sector). These firms may then trade allowances on a EU wide market. Given a well-functioning market such trading would reallocate allowances/emissions across ETS firms and thereby also across member states in a way that substantially lowers the costs

[1] Sweden (2002) states that the country's emissions 2008-12 must not exceed five times 96% of its emissions in 1990 while its AA equals five times 104% of that level. Corresponding figures for UK are 80% and 87.5%, respectively (UK, 2000).

[2] To enhance the cost-effectiveness of international climate policy, the Kyoto Protocol allows its Parties (or entities to whom they delegate the right) to engage in International Emissions Trading (IET), Joint Implementation (JI) and Clean Development Mechanism (CDM) activities. Under IET Parties may trade AA units (AAUs) multilaterally. Under JI a Party may finance emission-reduction projects in another Party and credit its AAU account by the amount of Emission Reduction Units (ERUs) the projects produce. The host country has to debit its AAU account with the same amount. Under CDM a Party may finance emission-reduction projects in countries without AAs and credit its AAU account by the emission reductions the UN CDM Executive Board deems the projects have generated, *i.e.*, the amount of Certified Emission Reductions (CERs). In addition, the Protocol allows the Parties to save AAUs/ERUs/CERs for use in subsequent compliance periods, so-called banking. Finally, the Protocol also allows the Parties to use carbon sinks to reallocate emissions reduction requirements over time. However, in this paper we abstract from the use of sinks. This omission has no principal effects on the analysis below.

of attaining the overall ETS emissions cap. For the first compliance period this cap amounts to the sum of the allowances the member states allot to their ETS firms. During the second period ETS firms may buy and transform, up to some limit, ERUs/CERs to ETS allowances as well as save allowances for use in subsequent compliance periods (EU, 2003a, 2003b). This implies that for the period 2008-12 the overall ETS emission cap will equal the sum of the national allotments *plus* the ETS firms' aggregate net import of ERUs/CERs *minus* their aggregate net banking of allowances.

To make the ETS consistent with the BSA and the KP, transfers of ETS allowances between ETS firms in different member states during 2008-12 will imply corresponding adjustments of the countries' AAU accounts (EU, 2003a). Hence, to comply with EU's burden-sharing agreement a member state cannot let its non-trading sector (households and non-energy intensive firms) emit more than the amount of AAUs the country has on its AAU account after the allotment made to its ETS firms. The member state can adjust this amount by engaging in IET/JI/CDM and use the banking mechanism of the KP.[3]

A member state equipped with a national emission target will instead control the emissions of its non-trading sector so that the national emissions level meets the target level. How much the emissions of the non-trading sector must be reduced will depend on how much the trading sector emits and thereby on the allowance price, a variable outside the control of an individual member country. This circumstance is likely to increase the costs of the country's climate policy. First, the realized allowance price and the "carbon prices" that entities in the non-trading sector must pay will most likely deviate from the pair of carbon prices the government would have induced, had it not been obliged to participate in the ETS. For studies on how the ETS affects the costs of individual countries' climate policies see, *e.g.* Hill and Kriström (2002) and Nilsson and Kriström (2002). Second, since the emissions level of the trading sector will not be known with any higher degree of certainty before the end of the compliance period the government may be forced to over-regulate the non-trading sector or to induce additional emission reductions with such a short notice that many low-cost adjustments are no longer

[3] The government may trade on the behalf of entities in the non-trading sector or delegate to these entities the right to engage in IET/JI/CDM.

available. For a discussion about other interaction effects between ETS and national climate policies, see *e.g.* Sorrell and Sijm (2003).

This note identifies another important interaction effect, namely that EU's greenhouse-gas emissions will be an increasing function of the aggregate net sales of allowances by trading sectors in countries with national emission targets. As explained below, this circumstance implies, among other things, that if Germany, Sweden and UK stick to their announced climate policies they would either fail to comply or "over comply"[4] with the burden-sharing agreement, depending on whether the aggregate net sale of allowances by these countries' trading sectors is positive or negative. As a consequence, EU would either fail to comply or over comply with the KP.

The next section presents the analysis. Concluding remarks are given in a third section.

2. Analysis

In order to study interaction effects between national – or countrywide – emission targets and participation in the ETS we have to distinguish EU member states equipped with such targets from other member states. Let country *C* represent the former group and country *O* the latter group, and let q_i denote the AA the burden-sharing agreement (BSA) gives country *i* (*i*=*C, O*) under the KP. In addition, let q_i^T be the amount of ETS allowances country *i* allots to its trading sector for the period 2008-12. Finally, let y_i^T be the net import of ERUs/CERs by trading sector *i*, and b_i^T its net banking of allowances. Now, we can state trading sector *C's* (*O's*) holding of allowances after trade with ERUs/CERs and banking of allowances <u>but before trade with trading sector *O* (*C*)</u> as

(1a) $\tilde{q}_C^T = q_C^T + y_C^T - b_C^T$

(1b) $\tilde{q}_O^T = q_O^T + y_O^T - b_O^T$

[4] By this term is meant a situation where countries' emission levels fall below their adjusted AAs whereby there exist AAUs that are not used to cover emissions in the current compliance period, banked/retired by these countries, or traded to Parties of the KP.

ETS requires that $e_C^T + e_O^T \leq \tilde{q}_C^T + \tilde{q}_O^T$, where e_i^T is trading sector *i*'s emissions during 2008-12. Given scarcity on allowances, a deterrent penalty for non-compliance,[5] and profit maximizing firms, this emission constraint will be binding, implying

(2) $\quad e_C^T = \tilde{q}_C^T + \left(\tilde{q}_O^T - e_O^T\right) \quad$ or $\quad e_O^T = \tilde{q}_O^T + \left(\tilde{q}_C^T - e_C^T\right)$

where trading sector *C*'s net sale of allowances equals trading sector *O*'s net purchase of allowances, *i.e.*, $\tilde{q}_C^T - e_C^T = -(\tilde{q}_O^T - e_O^T)$. Given information about marginal abatement costs (MACs) of the ETS firms it would be possible to calculate the competitive outcome on the ETS market. For our purposes, however, it suffices to note that as long as the MAC-functions of the ETS firms are increasing in abatements the competitive emissions level of each trading sector will be a decreasing function of the competitive allowance price and the competitive price will fall in the adjusted ETS cap $\tilde{q}^T = \tilde{q}_C^T + \tilde{q}_O^T$ (Montgomery, 1972).

As indicated in the Introduction, the part of its AA a member state does not transfer to its trading sector establishes an upper limit for how much the country's non-trading sector can emit without the country failing to comply with BSA. The member state can adjust this limit by engaging in IET/JI/CDM. Letting $q_i^N = q_i - q_i^T$ and y_i^N (b_i^N) denote the net import (net banking) of AAUs/ERUs/CERs by non-trading sector *i*, we can state the emissions cap the BSA implies for this non-trading sector as

(3a) $\quad \tilde{q}_C^N = q_C^N + y_C^N - b_C^N - r_C^N$

(3b) $\quad \tilde{q}_O^N = q_O^N + y_O^N - b_O^N - r_O^N$

where $r_i^N \geq 0$ is the amount of AAUs country *C* is planning to retire, if any. Letting e_i^N denote the emissions of the non-trading sector in country *i*, and presuming that country *O*

[5] EU (2003a) states a penalty of €100 per overshooting ton of carbon dioxide emissions and that the overshooting amount will be subtracted from the firm's allowance account in the next compliance period.

complies with the BSA, we have that $e_O^N = \tilde{q}_O^N$. Given this, country *O*'s total emissions e_O are obtained by adding the right-hand part of (2) to (3b)

(4) $$e_O = e_O^N + e_O^T = \tilde{q}_O + \left(\tilde{q}_C^T - e_C^T\right)$$

where $\tilde{q}_O = \tilde{q}_O^N + \tilde{q}_O^T$. Equation (4) just says that country *O*'s total emissions will equal its BSA allotment *plus* net import of AAUs/ERUs/CERs by its non-trading sector *plus* its trading sector's net purchase of ETS allowances. Guided by its national emissions target country *C* will behave in a different manner, however. Assuming that the government of country *C* will induce emission reductions in its non-trading sector just sufficient to meet the national emissions target $\bar{e}_C$,[6] the following equality will hold

(5) $$e_C^T + e_C^N = \bar{e}_C$$

Although countries with national emission targets cannot adjust their emission levels they may still engage in IET/JI/CDM. In fact, this is implied by the climate polices announced by Germany, Sweden and the UK. For instance, Sweden (2002) not only states that it will bank or retire the difference between its AA and its national emission target but also that it will engage in JI and CDM activities, the proceedings of which must be sold, retired or banked. Country *C*'s national emissions target implies the following restriction for its banking/retiring behavior and use of IET/JI/CDM.

(6) $$b_C^N + r_C^N = q_C - \bar{e}_C + y_C^N$$

So, country *C* must bank or retire AAUs to an extent that equals the sum of the difference between its BSA allotment and its national emissions target *plus* any net import of AAUs/ERUs/CERs by its non-trading sector.

[6] Any other assumption would imply that the national target is not $\bar{e}_C$.

Adding (4) to (5) yields EU's total greenhouse-gas emissions

$$(7) \qquad e = \bar{e}_C + \tilde{q}_O + \left(\tilde{q}_C^T - e_C^T\right)$$

Equation (7) contains our first result, namely that EU's emissions of greenhouse gases during 2008-12 will be an increasing function of trading sector *C*'s net sale of ETS allowances $\left(\tilde{q}_C^T - e_C^T\right)$. The driving force behind this result is the national emissions target of country *C*. To see this, ignore for the moment, without loss of generality, the possibilities ETS firms have to bank allowances and import ERUs/CERs, and consider a situation where all ETS firms are in compliance. Then, by reducing (increasing) its emissions by one additional unit, trading sector *C* will sell (has to buy) an additional allowance to (from) trading sector *O*. The firm in country *O* that buys (sells) this allowance will increase (must reduce) its emissions by one additional unit. Thus, this transaction does not affect the total emissions of the ETS and all ETS firms are still in compliance. However, guided by its national emissions target country *C* will, due to this transaction, allow (require) its non-trading sector to emit (abate) one additional unit. Hence, no additional emissions reduction (increment) is made in country *C* as a whole when its trading sector sells (buys) an additional allowance. Since trading sector *O*, at the same time, emits (abates) one additional unit, the result is that this transaction increases (decreases) EU's total emissions with one unit.

A corollary of eq. (7) is that EU's emissions during 2008-12 will be an increasing function of the amount of allowances country *C* allots its trading sector.[7] Consequently,

[7] Assume that the restriction on how many ERUs/CERs that can be transformed to ETS allowances is binding and that the ETS firms' banking decisions are fixed *i.e.*, that $\frac{\partial y_i^T}{\partial p} = \frac{\partial b_i^T}{\partial p} = 0$, where p is the competitive allowance price. Noting that $\frac{\partial y_i^T}{\partial p} = \frac{\partial b_i^T}{\partial p} = 0$ and (2) imply $\frac{\partial p}{\partial q^T} = \frac{1}{\frac{\partial e^T}{\partial p}} = \frac{1}{\frac{\partial e_C^T}{\partial p} + \frac{\partial e_O^T}{\partial p}}$, and differentiating (7) with respect to q_C^T we obtain after some manipulations that $\frac{de}{dq_C^T} = \frac{\varepsilon_O}{\varepsilon_O + \frac{e_C^T(p)}{e_O^T(p)}\varepsilon_C}$, where ε_i is the price elasticity of trading sector *i*'s demand for allowances. This expression is strictly positive as long as some but not all EU member states have national emission targets, *i.e.* $0 < \frac{e_C^T}{e_O^T} < \infty$. When the relative

EU's total emissions will differ from the level $\bar{e}_C + \tilde{q}_O$ the government of country *C* would expect with its national emission target. Only if the initial allocation of ETS allowances happened to be such that there was no net trade between trading sector *C* and trading sector *O*, would total EU emissions equal that target level.

Many, if not all, EU countries have domestic policy measures targeting their ETS firms' energy use or emissions of greenhouse gases.[8] In effect, such additional policy measures will reduce the competitive emission levels of the targeted ETS firms. However, as pointed out by, *e.g.*, Sorrell and Sijm (2003) this will merely increase the targeted firms' net sale of allowances while leaving total ETS emissions unaffected. A second corollary of eq. (7) is therefore that such additional domestic policies in countries with national emission targets will be contra-productive. For any given allotment of ETS allowances, the more these polices reduce the emissions of the targeted ETS firms the larger will these firms' net sale be and, hence, the larger will EU's total emissions be. It should also be noted that by lowering the emissions of the trading sector, these policies allow the non-trading sector to increase its emissions without breaking the national emissions target. Given the common expectations of allowance prices that are substantially lower than the carbon price that entities in the non-trading sector pay, the effect just mentioned would, as long as the ETS firms' marginal costs of complying with these additional policies are not too high, lower the country's total abatement costs.

We now turn to the question what our findings imply for EU's ability to comply with the KP. The KP requires

(8) $\quad e \leq \tilde{q}_C + \tilde{q}_O$

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size of trading sector *C* is small *e* goes up by almost as much as the increment in q_C^T. Allowing for $\frac{\partial b_i^T}{\partial p} < 0$ would imply a smaller impact on the emissions during 2008-12 but, at the same time, that aggregate emissions of subsequent compliance periods are correspondingly larger.

[8] For instance, Sweden has (i) a tradable green credit scheme stating how much "renewable" electricity retailers must purchase, (ii) subsidies to wind power production, and (iii) "voluntary agreements" between the government and energy intensive industries regarding these industries energy use (Sweden, 2002). The UK policy includes (I) energy taxation of energy intensive industries, (II) greenhouse-gas emissions trading schemes for the industry, and (III) a tradable green credit scheme (UK, 2000). The German policy includes support of renewable energy, combined heat and power generation and voluntary agreements between the industry and the government (Germany, 2003).

where $\tilde{q}_C = \tilde{q}_C^N + \tilde{q}_C^T$. Using (7) and (1a) to expand (8) we obtain $q_C^T - e_C^T \leq \tilde{q}_C - \bar{e}_C - y_C^T + b_C^T$. Then, noting that $\tilde{q}_C = q_C + y_C^T - b_C^T + y_C^N - \left(b_C^N + r_C^N\right)$ and inserting (6) we find that (8) holds if and only if

(9) $\quad q_C^T - e_C^T \leq 0$

Inequality (9) says that EU would fail to comply with the KP whenever the net sale of allowances by trading sector *C* is positive. When being negative, EU's emissions would fall below its adjusted AA and there would exist AAUs that are not used to cover EU emissions in the current compliance period, banked/retired by country *C*, or traded to Parties of the KP outside the EU. By assumption country *O* and trading sector *C* are in compliance with the BSA, eqs (4) and (3a), respectively. Thus, it is the non-trading sector in country *C* that fails to comply or over-comply with the BSA requires.

What we have shown here is that the climate policies announced by Germany, Sweden and the UK are inconsistent with the BSA and thereby also with the KP. Of course, countries' as well as firms' emission levels will be closely monitored whereby any tendencies toward non-compliance or over-compliance would likely be detected. The policies of Germany, Sweden and the UK would then be adjusted, perhaps long before 2012. So, the outcome that EU would over-comply or fail to comply with the KP should not necessarily be interpreted as a prediction. The point is that such policy adjustments would imply that Germany, Sweden and the UK conduct other policies than those they have announced.

To design policies consistent with the BSA, Germany, Sweden and the UK may (a) abandon their national emission targets, (b) change their banking/retirement behavior as compared to the announced one, (c) engage in IET/JI/CDM in a way that differs from the announced behavior, or (d) undertake some combination thereof. Let us first study the case where they retain their national emission targets. In terms of country C, this means that the adjusted policy satisfies eq. (5). Then, country *C* could choose any combination of (b) and (c) such that the cap implied by (3a) is respected, *i.e.*, $e_C^N = \tilde{q}_C^N$. Using (5) to eliminate e_C^N in this expression, inserting (2) and noting that $\tilde{q}_O^T - e_O^T = -\left(\tilde{q}_C^T - e_C^T\right)$, we

obtain $\bar{e}_C - \tilde{q}_C^T + (\tilde{q}_C^T - e_C^T) = \tilde{q}_C^N$. After expansion and simplification we get the following condition for a policy that is consistent with the BSA

(10) $$b_C^N + r_C^N = q_C - \bar{e}_C + y_C^N - \left(q_C^T - e_C^T\right)$$

It is easily seen that when trading sector *C*'s net sale of allowances is positive (negative) country *C* have to bank/retire less (more) and/or import more (less) AAUs/ERUs/CERs than it has announced, *cf.* eq. (6). Only in the event of zero net trade between trading sector *C* and trading sector *O* would this policy yield the announced behavior. It follows immediately from eq. (10) that the more allowances country C allots to its trading sector the less will it be able to bank/retire and/or the more AAUs/ERUs/CERs must it import to cover emissions of the non-trading sector.

Now, additional domestic policies targeting ETS firms would not render country C to fail to comply or over-comply with the BSA. Instead, by increasing the targeted firms' net sale of allowances, they would reduce the amount of AAUs country *C* can bank/retire and/or increase the amount of AAUs/ERUs/CERs it have to import on the behalf on its non-trading sector. So, these additional policies would reduce (increase) country C's banking account (import expenditures). Again, it should be noted that these additional policies at the same time are likely to reduce the aggregate abatement costs of the country. The net effect may well be a reduction in the country's total costs. It should also be noted that although consistent with the BSA, the policy prescribed by eq. (10) by retaining the national emissions target would give rise to the cost-enhancing interaction effects mentioned in the Introduction.

In order to design a policy consistent with BSA that also avoids the drawbacks just mentioned, country *C* would have to abandon its national emissions target. Then, to comply with the BSA country *C*'s emissions must not exceed the sum of the left-hand part of (2) and (3a). It should be noted that such a policy could be made consistent with any target level for the non-trading sector. The important thing is that this target level is independent of the emissions level of the trading sector.

3. Concluding Remarks

By relying on national emissions targets the announced climate policies of Germany, Sweden and the UK represent a regulation philosophy that stands in contrast to the philosophy behind EU ETS and the Kyoto Protocol. If implemented, the announced policies of Germany, Sweden and the UK would render EU's emissions during 2008-12 to be an increasing function of the aggregate net sale of allowances by British, German and Swedish ETS firms. One implication of this is that EU would fail to comply or over-comply with the Kyoto Protocol depending on whether the aggregate net sale of British, German and Swedish ETS firms is positive or negative. In other words, the announced policies of Germany, Sweden and the UK are incompatible with EU's burden-sharing agreement and the Kyoto Protocol and must be modified. To construct climate polices that are compatible with the EU burden-sharing agreement and that also avoid other costly, unintentional interaction effects discussed above, Germany, Sweden and the UK would have to abandon their national emission targets.

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